

APPENDIX E – INFORMATION SUPPORTING THE WATERSHED AND FISHERIES ANALYSIS

FISH/WATER QUALITY OBJECTIVES

Appendix A of the Nez Perce National Forest Plan lists fish/water quality objectives by prescription watershed for streams in the analysis area. Fish/water quality objectives displayed below provide management direction in terms of maximum sediment yield over baseline conditions that can be approached or equaled for a specified number of years per decade, ranging from one to three times. Watersheds with fish/water objectives of 90 percent are allowed one entry per decade, those with 80 percent are allowed two entries per decade and those with 70 percent are allowed three entries per decade. All objectives are relative to full habitat potential of 100 percent.

FISHERY/WATER QUALITY OBJECTIVES IN APPENDIX A OF THE NEZ PERCE NATIONAL FOREST PLAN

TABLE E.1: AMERICAN RIVER

Prescription Watershed	Prescription Watershed Name	Beneficial Use	Current Fishery Habitat Condition (%)	Fishery Water Quality Objective (% habitat potential)	Sediment Yield Guideline (% over baseline)	Entry Frequency Guideline (per decade)
17060305-05-06	Middle American River ¹	A	50 %	90 %	30 % ²	1
17060305-05-09	Upper American River ¹	A	60 %	90 %	30 %	1
17060305-05-10	East Fork American River ¹	A	60%	90%	30% ²	1
17060305-05-11	Kirks Fork ¹	A	50 %	90 %	30 %	1
17060305-05-12	Whitaker Creek	R	70 %	70 %	60 %	3
17060305-05-13	Queen Creek	R	70 %	70 %	60 %	3
17060305-05-14	Flint Creek ¹	A	40 %	90 %	30 %	1
17060305-05-15	Box Sing Creek	R	70 %	70 %	60 %	3
17060305-05-16	Lower American River ³	A	50 %	90%	30 % ²	1

¹ These streams are suffering from both a lack of diversity (similar to category 1) and excess sediment from past roading and timber management activities. Along with increasing diversity through direct habitat improvement, state-of-the-art techniques will be used to remove sediment from the gravel environment. Improvements will be scheduled between 1986 and 1995. Timber management can occur in these watersheds, concurrent with habitat improvement efforts, as long as a positive, upward trend in habitat carrying capacity is indicated.

² These prescription watersheds, unlike most, are not true watersheds. By definition, a true watershed includes all the lands draining through a stream reach. These footnoted watersheds drain only part of such a hydraulic unit and generally contain the downstream reaches of relatively large streams. For sediment yield analysis on these downstream reaches, all upstream prescription watersheds are combined into a true watershed. Sediment yield guidelines (Column 6) apply only to true watersheds. Entry frequency guidelines (Column 7) apply to prescription watersheds regardless of whether they are true watersheds.

³ Lower American River was not included in Appendix A of the Forest Plan. Objectives and guidelines are those recommended for use in the American/Crooked Project.

TABLE B-2: CROOKED RIVER

Prescription Watershed	Prescription Watershed Name	Beneficial Use	Current Fishery Habitat Condition (%)	Fishery Water Quality Objective (% habitat potential)	Sediment Yield Guideline (% over baseline)	Entry Frequency Guideline (per decade)
17060305-03-01	Lower Crooked River ¹	A	50 %	90 %	30 % ²	1
17060305-03-03	Relief Creek ¹	A	60%	90 %	30 %	1
17060305-03-04	Middle Crooked River	A	90 %	90 %	30 % ²	1

In Forest Plan Appendix A, there were three general beneficial use designations, anadromous fisheries (A), resident fisheries (R) and municipal watershed (MW). Only the first two are present in project area watersheds.

The watershed numbering and nomenclature system has evolved over the past twenty years. At the time of the Forest Plan (1987), the Hydrologic Unit Code (HUC) system was nationally coordinated to the 4th code HUC (e.g. South Fork Clearwater River subbasin = 17060305). Efforts are currently underway to nationally coordinate HUCs to the 6th code level. This analysis relies on the older codes.

At the time of the Forest Plan, 6th code watersheds were referred to as prescription watersheds. Current nomenclature refers to those as subwatersheds. Also, 5th code watersheds were referred to as NFS (National Forest System) watersheds. Current nomenclature refers to those as simply watersheds.

Prescription watersheds such as Lower American River and Lower Crooked River pose a unique situation in that they are not a single complete drainage (see footnote above). At the time of the Forest Plan, these were called face drainages. Current terminology refers to them as composite watersheds. Those watersheds called true watersheds at the time of the Forest Plan are now referred to as pure watersheds. The maps below show how composite and pure watersheds are related in the project area.

¹ Streams listed in the category are below carrying capacity due primarily to a lack of diversity (pool structure). This problem is caused by the removal of all large boulders and woody debris from the stream through placer mining. These habitat components will be replaced through direct habitat improvement projects. Work will be scheduled in the latter part of the first decade (1989-1995). Work in Crooked River is underway, with an expected completion date of 1989. Timber management activities can occur in these drainages, concurrent with habitat improvement efforts, as long as a positive, upward trend in habitat carrying capacity is indicated.

² These prescription watersheds, unlike most, are not true watersheds. By definition, a true watershed includes all the lands draining through a stream reach. These footnoted watersheds drain only part of such a hydraulic unit and generally contain the downstream reaches of relatively large streams. For sediment yield analysis on these downstream reaches, all upstream prescription watersheds are combined into a true watershed. Sediment yield guidelines (Column 6) apply only to true watersheds. Entry frequency guidelines (Column 7) apply to prescription watersheds regardless of whether they are true watersheds.

Figure E.1: Composite v Pure Watersheds - American River

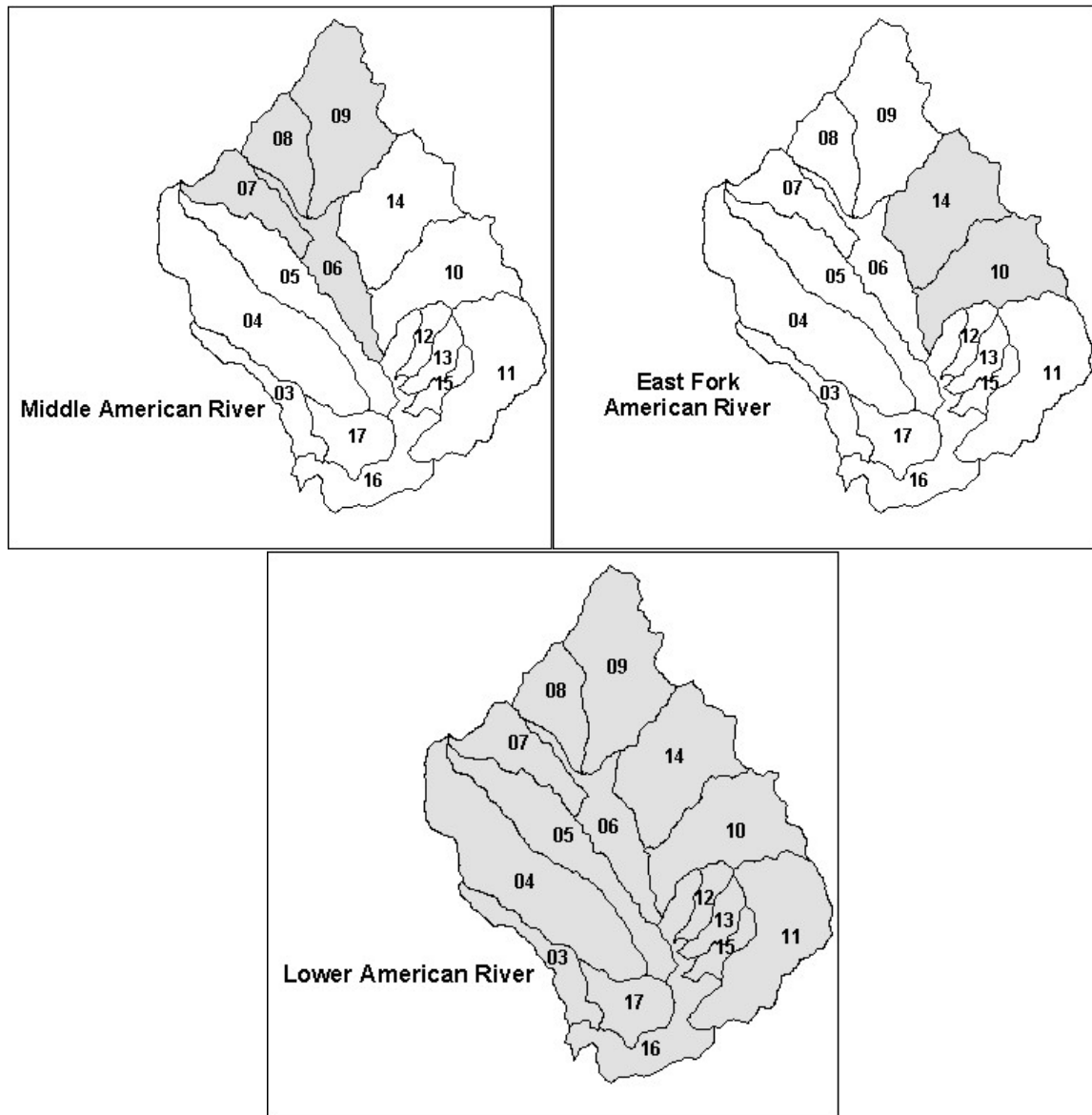
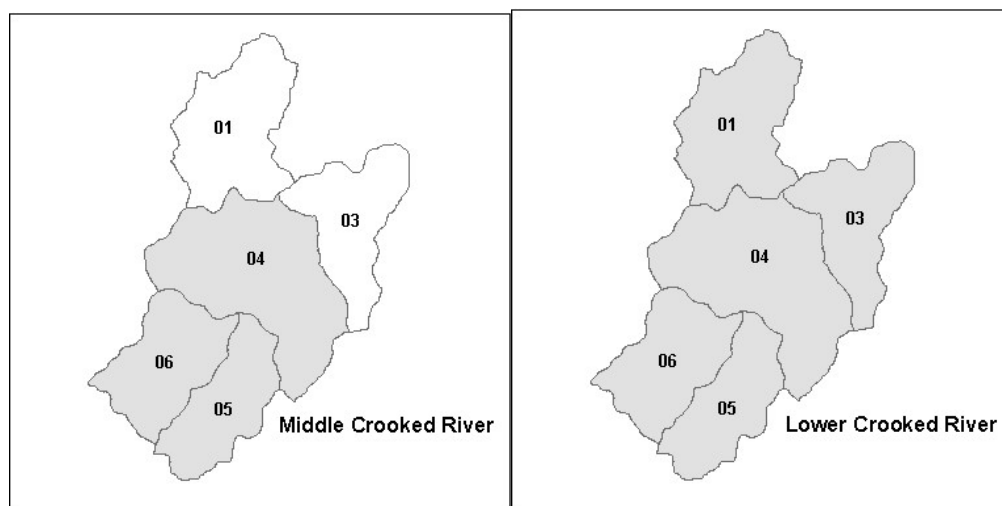


Figure E.2: Composite v Pure Watersheds – Crooked River

For purposes of water yield (ECA) and sediment yield (NEZSED) analysis, composite watersheds are compiled into larger pure watersheds. This is done in order to maintain integrity with the assumptions used to develop the ECA and NEZSED procedures. Both of these models assume the water yield and sediment yield reflect the conditions in the entire pure watershed above the analysis point (also known as pour point).

Each of the maps above shows the relationship between composite and pure watersheds for the American and Crooked River watersheds. Using Lower Crooked River as an example, when ECA or NEZSED results are reported, they include all of the shaded subwatersheds. For more detail on the watershed boundaries and associated stream systems, see Maps 7a and 7b.

UPWARD TREND

The Nez Perce Forest Plan provides direction that timber harvest in sediment-limited watersheds that do not meet their Fish/Water Quality objectives, as listed in Appendix A, would occur only where concurrent watershed improvement efforts result in a positive upward trend in habitat condition. Many of the area streams do not meet their objectives and are in this category. Those are the watersheds with footnotes 1/ and 2/in Tables E.1 and E.2.

THE DFC TABLES

To estimate natural fish habitat potential and quantify existing stream conditions as required by the Forest Plan, the Nez Perce National Forest is using a Desired Future Condition (DFC) Model developed on the Clearwater National Forest (Espinosa 1992). This model addresses specific conditions and channel types found on the Nez Perce Forest using a habitat quality index. Values for the habitat parameters are quantified in a set of desired future condition (DFC) tables. The DFC tables list the specific fish habitat parameter and a value or range that a stream should have in order to be at a given percentage of the streams potential and to meet the Forest Plan Objectives for that watershed. The DFC values, habitat parameter data and their relationships are stratified by channel types and fish species. The values for the fish habitat parameters listed in the DFC tables are considered achievable for streams under natural conditions in the absence of major disturbances or are reflective of what good fish habitat should be. Most of the habitat parameters are consistent for each species, and they vary slightly by channel type. Past work has shown a need to adjust some of

the elements to better-fit natural conditions and what is achievable. The DFC for acting and potential woody debris in a meadow channel is often used as an example of this.

FOREST PLAN RIPARIAN AREA DIRECTION

In addition, the Nez Perce Forest Plan defines standards for vegetation management in riparian areas (Management Area 10), which are collectively defined as lakes, lakeside lands, perennial streams, seasonally flowing streams supporting riparian vegetation, and adjoining lands that are dominated by riparian vegetation (NPFP III-30-33). This area includes the floodplains of streams and the wetlands associated with springs, lakes, and ponds. Guidelines include the following:

- Consider cumulative impacts of proposed actions on the entire riparian ecosystem
- Manage riparian areas to maintain and enhance their value for wildlife, fishery, aquatic habitat, and water quality.
- Maintain sufficient streamside vegetative canopy to ensure acceptable water temperatures for fish and to provide cover.
- Management activities shall not be permitted to adversely change the composition and productivity of key riparian vegetation. Riparian areas now degraded by management should be rehabilitated before any further nondependent resource use.
- Planned ignitions, when within prescription, would be allowed to burn to enhance resource values.

FOREST PLAN AMENDMENT 20 (PACFISH)

The PACFISH Environmental Assessment amended the Nez Perce Forest Plan in 1995 and is incorporated as Amendment 20. PACFISH establishes riparian goals, riparian management objectives (RMOs), and defines riparian habitat conservation areas (RHCAs). It includes specific direction for land management activities within riparian areas adjacent to streams, lakes, wetlands, and landslide-prone terrain. Riparian goals establish an expectation of the characteristics of healthy, functioning watersheds, riparian areas, and fish habitat. The goals direct the Forest to maintain or improve habitat elements such as water quality, stream channel integrity, instream flows, riparian vegetation, and several others.

Riparian management objectives (RMOs) for stream channel condition provide the criteria against which attainment, or progress toward attainment, of the riparian goals is measured. They include habitat attributes such as number of pools, amount of large wood in the channel, stability of the stream banks, and width-to-depth ratio. The areas adjacent to streams and wetlands (RHCAs) were established in PACFISH to maintain the integrity of aquatic ecosystems. Healthy riparian areas are essential to maintaining or improving the quality of fish habitat in streams. This analysis will use a combination of DFC and RMO values to define existing conditions in watersheds where activities occur.

Direction in PACFISH specific to Timber Management/Silviculture includes the following:

PROHIBIT TIMBER HARVEST, INCLUDING FUEL WOODCUTTING, IN RHCAs, EXCEPT IN THE FOLLOWING CONDITIONS:

- Where catastrophic events such as fire, flooding, volcanic, wind, or insect damage result in degraded riparian conditions, allow salvage and fuel wood cutting in RHCAs only where present and future debris needs are met, where cutting would not retard or prevent attainment of RMOs, and where adverse effects on anadromous fish can be avoided.

- Apply silviculture practices for RHCAs to acquire desired vegetation characteristics where needed to attain RMOs. Apply silviculture practices in a manner that does not retard attainment of RMOs and that avoid adverse effects on listed anadromous fish.

Direction in PACFISH specific to Fire/Fuels Management and relevant to this project includes the following:

- Design fuel treatment and fire suppression strategies, practices, and actions so as not to prevent attainment of Riparian Management Objectives, and to minimize disturbance of riparian ground cover and vegetation.
- Strategies should recognize the role of fire in ecosystem function and identify those instances where fire suppression or fuel management actions could perpetuate or be damaging to long-term ecosystem function, listed anadromous fish, or designated critical habitat.

Direction in PACFISH specific to Recreation Management and relevant to this project includes the following:

- Design, construct, and operate recreation facilities, including trails and dispersed sites, in a manner that does not retard or prevent attainment of Riparian Management Objectives and avoids adverse effects on listed anadromous fish... Relocate or close recreation facilities where Riparian Management Objectives cannot be met or adverse effects on listed anadromous fish avoided.
- Adjust dispersed and developed recreation practices that retard or prevent attainment of RMOs or adversely affect listed anadromous fish. Where adjustment measures such as education, use limitations, traffic control devices, increased maintenance, relocation of facilities, and/or specific site closures are not effective in meeting RMOs and avoiding adverse effects on listed anadromous fish, eliminate the practice or occupancy.

Direction in PACFISH specific to Fisheries/Wildlife Restoration includes the following:

- Design and implement fish and wildlife habitat restoration and enhancement actions in a manner that contributes to attainment of RMOs.

CHANNEL MORPHOLOGY AND SEDIMENT ROUTING

Stream gradient is an important parameter that has implications for sediment transport and deposition. It is also related to fish habitat quality, since many species prefer lower gradient stream reaches for certain life stages. Lower gradient reaches on 3rd to 5th order streams in the project area are particularly well-suited for Chinook salmon and steelhead spawning. The data below were compiled with GIS methods using the 1:24,000 scale NHD stream layer and 30 meter DEM data.

TABLE E.3: PERCENT STREAM LENGTH BY GRADIENT CLASSES – AMERICAN RIVER

Watershed Name	Stream Miles	<2%	2-4%	4-10%	10-20%	20-40%	>40%
Middle American River ¹	12.8	45	12	34	9	0	0
East Fork American River ¹	19.6	12	12	28	39	9	0
Flint Creek	23.8	13	20	34	26	7	0
Whitaker Creek	4.6	6	2	46	33	12	0
Queen Creek	4.8	6	12	67	16	0	0
Box Sing Creek	4.1	11	6	36	46	0	0
Kirks Fork	26.8	8	8	37	35	11	1
Lower American River ¹	17.7	53	4	12	29	2	0

TABLE E.4: PERCENT STREAM LENGTH BY GRADIENT CLASSES – CROOKED RIVER

Watershed Name	Stream Miles	<2%	2-4%	4-10%	10-20%	20-40%	>40%
Middle Crooked River ²	50.2	10	8	26	39	17	0
Relief Creek	23.2	14	5	36	34	11	0
Lower Crooked River ¹	40.0	20	2	15	39	21	4

SEDIMENT ROUTING

Sediment routing considers the disposition of sediment within the watershed system, including processes of erosion, deposition, storage and transport. It includes upslope and instream components. The upslope component includes initial detachment, erosion and delivery efficiency. The instream component includes suspended and bedload sediment yield, as well as substrate deposition and composition. The instream component also includes consideration of streamflow and channel morphology, both of which influence the capability of the stream to transport or deposit sediment.

EROSION AND DELIVERY PROCESSES

The erosion process initiates with detachment of material. Detachment can occur through weathering processes such as frost heave or raindrop impact. Erosion can occur as dry ravel, surface erosion (e.g. sheet, rill and gully) and mass erosion (e.g. debris avalanches, slumps and earthflows). The rate of each is dependent on climate, landforms, geology, soils and exposure of mineral soil. For freshly exposed materials, surface erosion is probably the dominant process in the Red River landscape. Transport occurs when rainfall or snowmelt generate water in sufficient quantities to carry the detached materials.

In most cases, a large proportion of eroded material is stored on the landscape without being delivered to the channel system. Storage can take place in hollows and flats or behind obstructions. It can also occur on slopes if the water transporting the material infiltrates. Delivery efficiency has

¹ Data compiled for composite watersheds, not pure watersheds

² Data compiled for composite watersheds, not pure watersheds

been estimated for each landtype on the NPNF. Sediment is considered to be delivered to the channel system when it reaches a stream with defined bed and banks. Within the sediment model, this is assumed to occur at a catchment area of 1 mi² (USDA Forest Service, 1981).

INSTREAM PROCESSES

Once sediment is delivered to the channel system, it is subject to transport or deposition. Transport can occur as suspended or bedload sediment. Fine materials, such as clay, silt and fine sand are transported in the water column as suspended sediment. This material usually travels through the system rapidly and only deposits in still water. It contributes to the turbidity that is seen during runoff events. During active runoff periods the travel time of suspended sediment through the Red River watershed and out of the South Fork Clearwater River subbasin is less than 24 hours. Monitoring at gaging stations in nearby Red River has indicated that suspended sediment constitutes about 40 percent to 60 percent of the annual sediment yield (Gloss, 1995). Recent analyses with a larger dataset suggest that suspended sediment may be a higher proportion of total sediment yield.

Bedload sediment moves along the channel bottom and typically consists of medium and coarse sand, gravel and cobble. Boulders may occasionally move as bedload, but only for short distances in any given event. Bedload transport and deposition is a complex and intermittent process. It is highly dependent on stream energy in terms of streamflow and channel morphology. Under given conditions of streamflow, a river could transport or deposit bedload sediment in different reaches or habitat units, depending on gradient and cross-sectional characteristics. Bedload transport is an episodic process that occurs at higher streamflows, with the majority occurring at discharges approaching bankfull and above. Under low and moderate flow conditions, very little if any bedload is in transport.

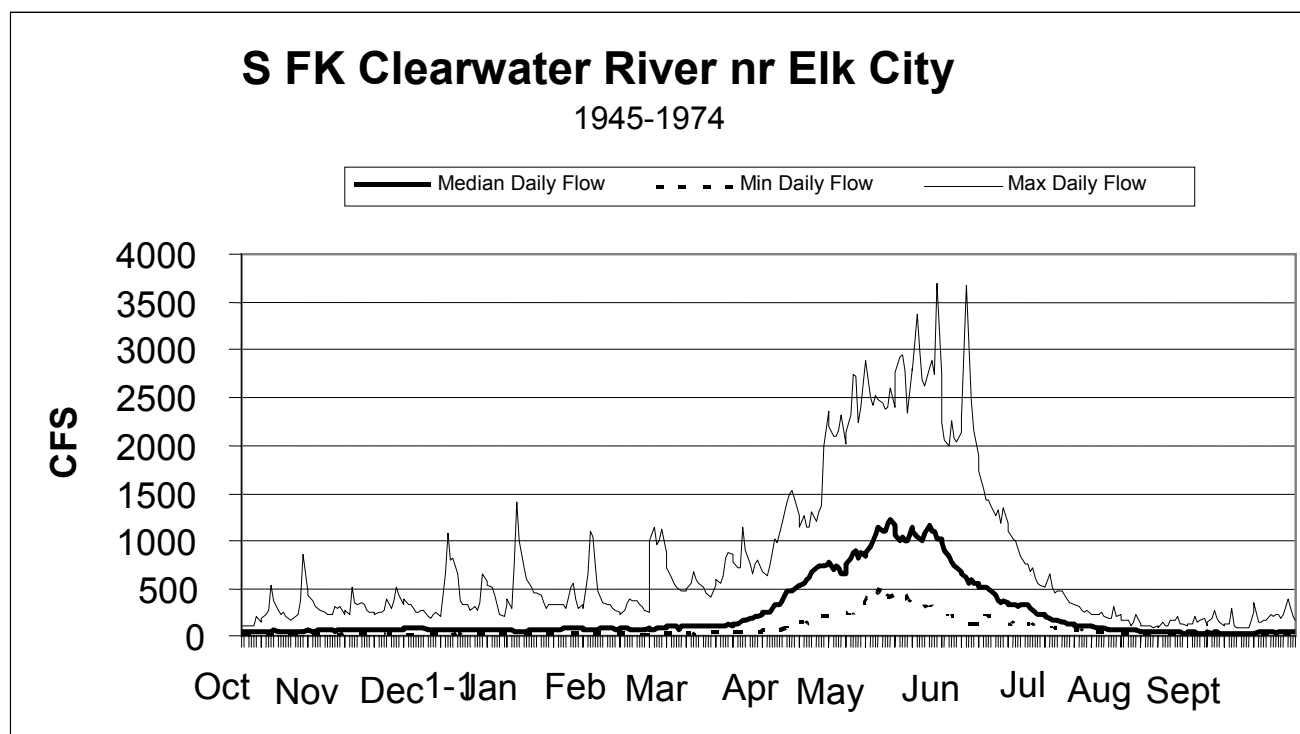
Materials of various sizes are deposited between episodes of transport. Deposition can involve fines (i.e. sand) intruding into coarse substrates or covering the stream bottom. When large amounts of coarse substrates are deposited, aggradation and changes in bedforms can result. In some cases this can lead to further adjustments, such as bank erosion and changes in channel morphology. Storage of deposited sediment within a given habitat unit or reach may be relatively short, for example between flow events or seasons. In other cases, storage can be on the order of years to indefinitely.

Stream gradients for the American and Crooked River watersheds are described above in Tables E.3 and E.4. Lower gradient reaches are particularly susceptible to sediment deposition and relatively long term storage. With regard to sediment deposition and transport, one classification system suggests that channels with <3 percent gradient can be considered response reaches and channels with >3 percent gradient can be considered either transport or source reaches (Montgomery and Buffington, 1993).

In subwatersheds affected by project activities in American River, Middle American and Lower American both have >45 percent of their channel system with gradient <2 percent. Conversely, the other subwatersheds all have >60 percent of their channel system with gradient >4 percent. In subwatersheds affected by project activities in Crooked River, all have >60 percent of their channel system with gradient >4 percent.

FLOW REGIME

The flow regime for American and Crooked Rivers is similar to the upper South Fork Clearwater River. The data represented below were collected by the USGS just upstream of the mouth of Crooked River. Though discontinued in 1974, this stream gage was re-established in 2002 and is currently in operation.

Figure E.3: Annual Hydrograph

AQUATIC MODEL DISCLOSURES

This section discloses the assumptions, limitations, management thresholds, and field tests associated with the three aquatic effects models used in the American and Crooked River project analysis. The models are Equivalent Clearcut Area (ECA), NEZSED, and FISHSED.

EQUIVALENT CLEARCUT AREA (ECA)

The ECA model procedures are derived from Forest Hydrology, Part II (USDA Forest Service, 1974). Equivalent Clearcut Area (ECA) analysis is a tool used to index the relationship between vegetation condition and water yield from forested watersheds. The basic assumptions of the procedure are that removal of forest vegetation results in water yield increases and that ECA can be used as an index of these increases. Depending on the interaction between water yield, sediment yield, and stream channel conditions, such increases could have impacts on stream channels.

Water yield increases can be directly modeled, but equivalent clearcut area (ECA) is often used as a surrogate. The ECA model is designed to estimate changes in mean annual streamflow resulting from forest practices or treatments (roading, timber harvest, and fires), which remove or reduce vegetative cover, and is usually expressed as a percent of watershed area (Belt, 1980). The index takes into account the initial percentage of crown removal and the recovery through regrowth of vegetation since the initial disturbance. For purposes of this assessment, ECA will be used to index changes in water yield through time based on timber harvest and roading disturbances.

There are a number of physical factors that determine the relationship between canopy conditions and water yield. These include interception, evapotranspiration, shading effects and wind flux. These factors affect the accumulation and melt rates of snow packs and how rainfall is processed. The ECA analysis takes into account the initial percentage of crown removal and the recovery through

vegetative re-growth since the initial disturbance in the case of timber harvest or fire. Within the habitat types being treated under this project, the time frame for complete ECA recovery to occur is estimated to be 65 to 85 years (USDA Forest Service, 1974).

Additional factors affecting water yield include compacted surfaces due to roads, skid trails, and landings. Existing and new roads are considered as permanent openings in the ECA model. Decommissioned roads are considered as openings, so the road decommissioning projects do not contribute to reductions in ECA.

The ECA model does not directly account for the effects of peak flows. Peaks flows in the project area are nearly always associated with spring snowmelt, at times accompanied by rainfall. This can be seen in Figure E.3. Winter rain-on-snow events are historically rare and only infrequently exceed the spring runoff peak. About 3 percent of annual peak flow events have occurred during the winter months of November through March (USDA Forest Service, 1998). The effects of peaks flows are considered using professional judgment in the interpretation of ECA effects on stream channels.

Various ECA thresholds of concern have been in use in the Northern Region since the 1960s (Gerhardt, 2000). Early cutting guides recommended a limit of 20-30 percent ECA within a watershed (Haupt, 1967). More recently, ECA thresholds have been rejuvenated through consultation under the Endangered Species Act. A recent Biological Opinion stipulated that watershed analysis should be conducted prior to actions that would increase ECA in 3rd to 5th order priority watersheds where ECA exceeds 15 percent (National Marine Fisheries Service, 1995).

Recently, concern over water yield changes relative to stream channel condition has focused on smaller headwater catchments. Research in the nearby Horse Creek watershed study have demonstrated instantaneous peak flow increase up to 34 percent and maximum daily flow increases up to 87 percent, resulting from road construction and timber harvest in small catchments (King, 1989). Recent observations have suggested that channel erosion from these streams may be contributing to increased bedload sediment in the 3rd order receiving channel (Gerhardt, 2002).

The studies by Belt (1980) and King (1989) have also served as field tests of the ECA procedure. Belt concluded that the ECA procedure is a rational tool for evaluation of hydrologic impacts of forest practices. King recommended local calibration of the model and a greater emphasis on conditions in 1st and 2nd order headwater streams.

NEZSED

NEZSED is a computer model tiered to the R1R4 guidelines (Cline, et al, 1981), developed by hydrologists and soil scientists from the Intermountain Research Station and the Northern and Intermountain Regions of the Forest Service. The model estimates the average annual natural or base rate of sediment yield, and surface erosion sediment yield produced from roads, logging, and fire. The model is limited in that it does not consider the effects of activities on mass erosion greater than 10 cubic yards. It also does not include the effects of grazing and most instream and mining activities. Effects of land uses other than roads, logging and fire are analyzed using other information and techniques.

For this analysis, NEZSED was used to model timber harvest, temporary road construction, reconstruction of existing roads and road decommissioning. Activities under this project that are not modeled are soil restoration, trail improvements, recreation site improvements and stream channel restoration. The effects of these other activities were considered in the overall aquatic analysis and conclusions.

Though the model shows annual variations in response to land use, it does not estimate variations due to climate or weather events. NEZSED is not an event-based model in that sediment yield does not vary in accordance with specific assumed runoff or erosion events. It estimates average annual

sediment yields. However, modeling coefficients are the result of a research base that includes the cumulative result of individual storm and runoff events. Thus, the effects of storm events are incorporated into the model coefficients, though the model results are expressed in terms of average annual yields.

Though NEZSED does not model large activity-related mass erosion events, effects of such events are considered in the effects analysis. This is done through mapping of landslide prone terrain and avoidance of areas deemed to possess high hazard and mitigation of areas deemed to possess moderate hazards. Mass erosion occurrences were also noted during field inventories.

Management thresholds for sediment yield were established in Appendix A of the Nez Perce National Forest Plan (USDA Forest Service, 1987). These include sediment yield guidelines, expressed as peak year percent over base sediment yield, and entry frequency guidelines, expressed as the number of times per decade that sediment yield guidelines can be equaled. For the American and Crooked River project, these guidelines are found in Tables E.1 and E.2.

NEZSED has been tested against field sampled data in several studies at three scales of watersheds across the Nez Perce National Forest (Gerhardt, 2005). The first study compared measured and modeled natural sediment yields at fifteen small watersheds that are tributaries to Horse Creek, which is a tributary of the Meadow Creek watershed draining into the Lower Selway Subbasin (Gerhardt and King, 1987). These watersheds ranged in size from 0.08 to 0.57 square miles. Annual sediment yield was sampled with sediment detention basins, suspended sediment samples, and streamflow gaging. Of the fifteen tributaries sampled, the model over-predicted sediment yield on nine sites and under-predicted on six sites. The mean result was that the model over-predicted by about 23 percent.

The second study evaluated data from eight stream gaging stations on the Nez Perce National Forest, ranging in size from 5.7 to 113 square miles. Three of these were located within the South Fork Clearwater Subbasin (Gloss, 1995). At six stations, the field data consisted of suspended and bedload sediment samples, along with streamflow gaging. At two stations, sediment yield was estimated through the use of sediment detention basins and streamflow gaging. This study found that NEZSED under-predicted sediment yields at six stations and over-predicted at two stations, when compared to observed data from field sampling during water years 1986 through 1993. For the three stations within the South Fork Clearwater Subbasin, field-sampled sediment yields averaged about 30 tons/mi²/yr. and modeled sediment yields averaged about 12 tons/mi²/yr. In general, the model predicted better in average to below average water years, and more significantly under-predicted in above average water years.

A third study to test the NEZSED model compared field sampled and modeled sediment yield at the subbasin scale, using data from the South Fork Clearwater and Selway Rivers. Sampling in both rivers occurred between 1988 and 1992 and consisted of 52 suspended sediment samples. The South Fork data were collected at the Mt. Idaho Bridge, near the forest boundary where the watershed area is about 830 square miles. When calculated as annual sediment yield, these data suggest an annual sediment yield at this site of 17,880 tons/year, or about 22 tons/mi²/yr. Sediment yield predictions at this site, based on NEZSED, were estimated to be 15,080 tons per year, or about 18 tons/mi²/yr (USDA Forest Service, 1998).

The Selway River data were collected at the USGS gage near Ohara Creek, where the watershed area is about 1910 square miles. When calculated as annual sediment yield, these data suggest a sediment yield at this site of 54,900 tons/year, or if adjusted to the mouth, 55,700 tons/year. The watershed area at the mouth is 1974 square miles, so the sediment production is 28 tons/mi² /yr. Sediment predictions based on modeled sediment at the mouth of the Selway River were 54,400 tons/year or about 27.5 tons/mi²/yr (USDA Forest Service, 2001).

A fourth study (Thomas and King, 2004) tested NEZSED against measured data at stream gages in Red River and South Fork Red River. Results showed that NEZSED predicted 74 percent and 89

percent, respectively, of field-sampled sediment yield over a 16-year period at these two gaging stations. The model results were closer to measured values at these two stations than found in the Gloss study.

FISHSED

The Guide for Predicting Salmonid Response to Sediment Yields in Idaho Batholith Watersheds (Fishsed model) has been used in this project to predict the effect of sediment yields on stream habitat and fish populations. This model is based on assumptions and has limitations.

The assumptions of the Fishsed model are listed in Appendix A of the model documentation (Stowell et al, 1983). Some of the key assumptions with influence on the limitations of this model include: 1) on those Forests in which mass erosion is a significant hazard, predicted sediment yield will include a mass erosion component. The American and Crooked River Project does not occur in a landscape where mass erosion is a significant hazard. 2) The relative response of salmonid fish populations to increased levels of sediment and percent fines in the substrate as depicted in laboratory studies approximates the response under natural conditions. The model documentation (p. 6) describes studies that support this assumption and others that show some differences.

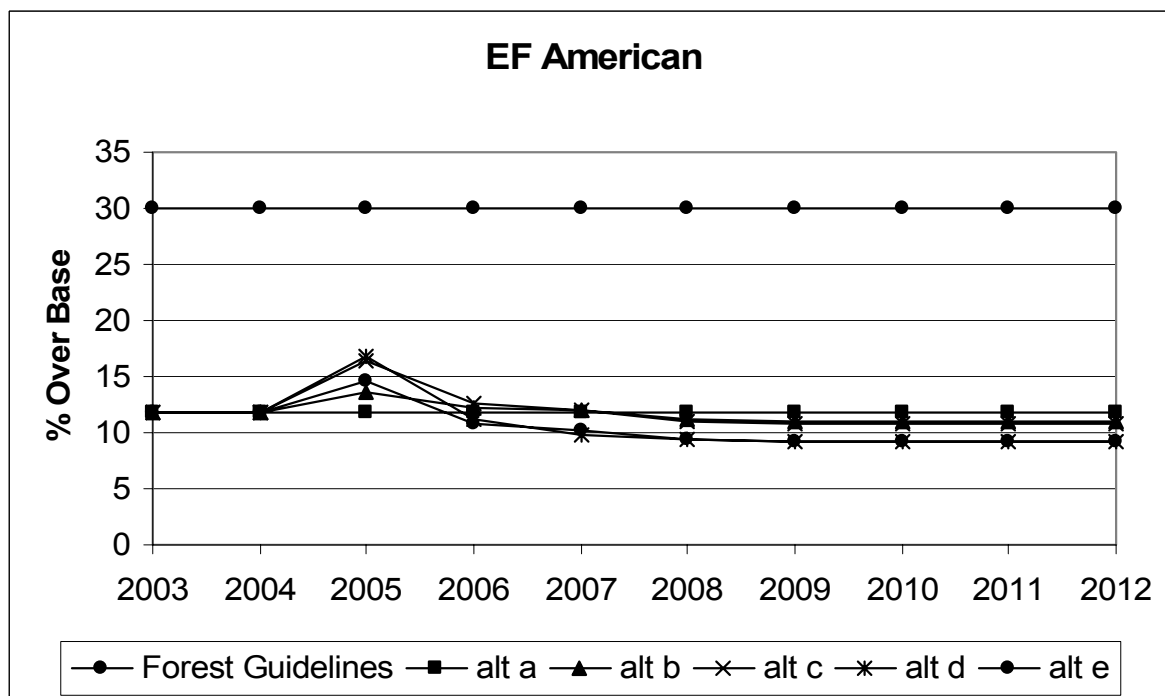
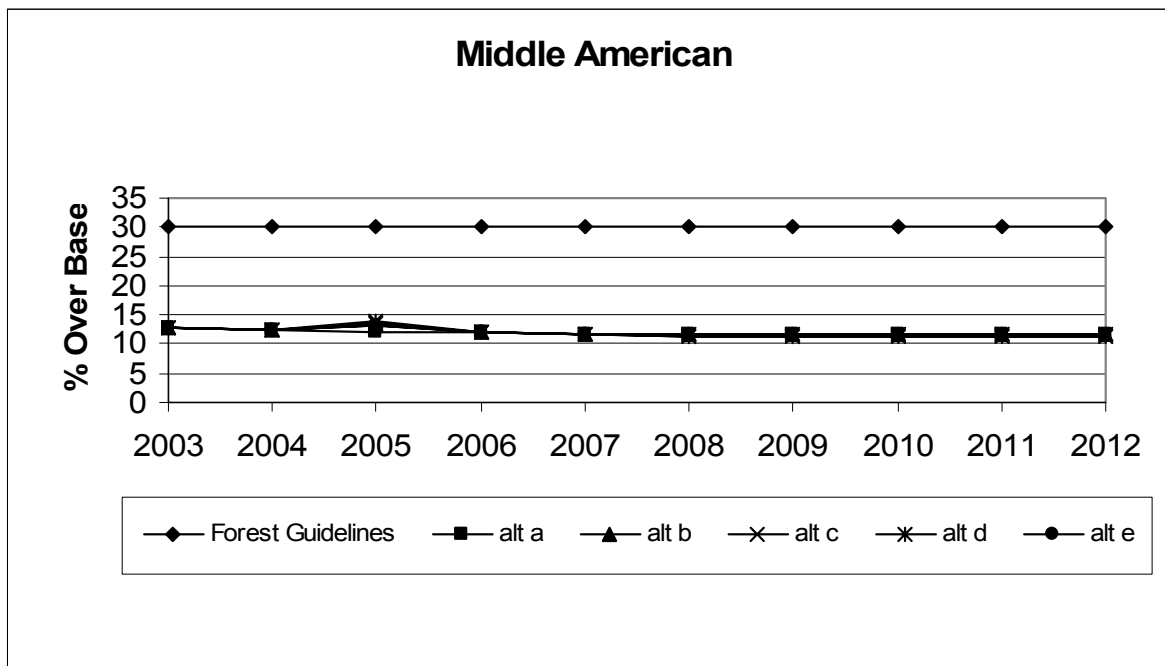
The Fishsed model has other recognized limitations including: 1) the model simplifies an extremely complex physical and biological system and is developed from limited scientific knowledge (p. 2). The complex sequence of sediment movement from the slopes to the channel, transport down, and deposition in a channel reach, and its effect on fish habitats and populations have not been fully described (p. 5). 2) The method was developed for watersheds and fish species associated with the Idaho Batholith (p. 4), using data from the Clearwater and Nez Perce National Forest. Given the source of the original data, the model is applicable to the American and Crooked River Project. 3) The specific fish response curves in this model were partially developed from laboratory experiments and may constitute only partial simulation of natural conditions (p. 6). 4) The model evaluates embryo survival, winter carrying capacity, and summer rearing capacity. While invertebrate insect abundance may be directly affected by sediment, the relationship between sediment deposition and invertebrate production is not included in the model (p.10). 5) The utilization of channel types to stratify fish response, particularly with respect to the modeling of “A” channel types, may not realistically represent changes in fish habitat (p. 21). 6) The model does not include a ‘recovery function’ that predicts the changes in substrate condition based on natural flow events. 7) The model was calibrated to the original Nez Perce Forest sediment model and landtypes, which have been updated since model development. No subsequent testing or validation of the model has occurred on the Forest. 8) The model outputs are reasonable estimates, but are not absolute numbers of high statistical precision (p. 6). As appropriate given this limitation, the model outputs have been used by the fisheries biologists in this project in combination with sound biological judgment.

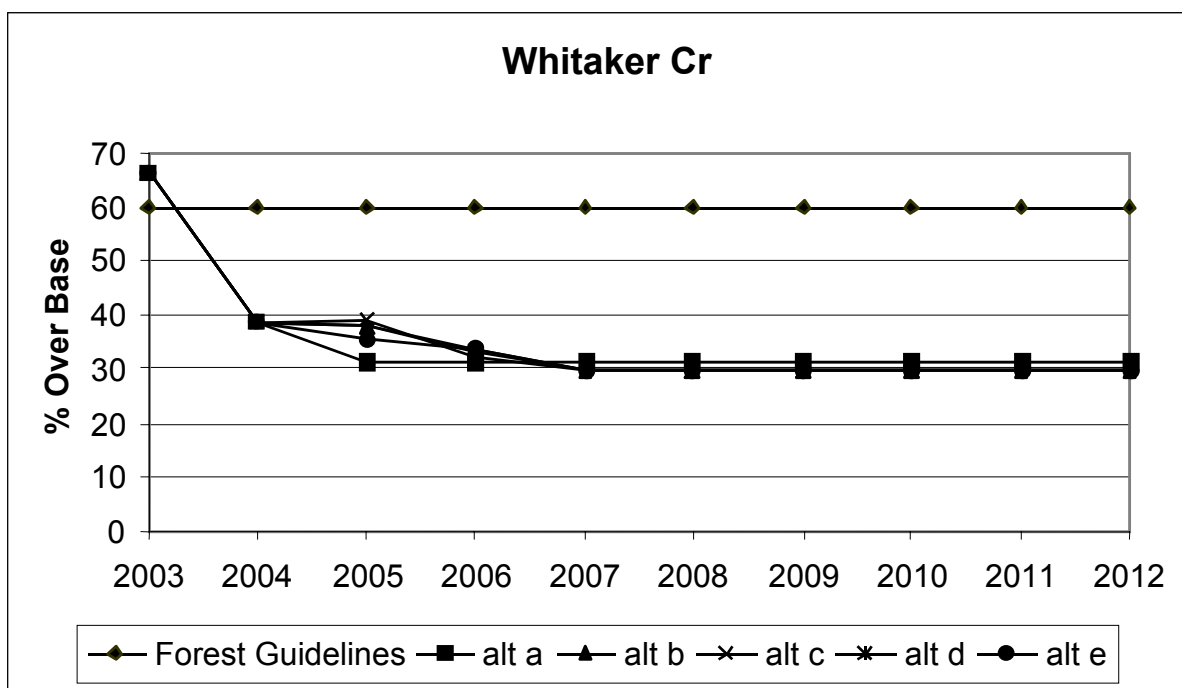
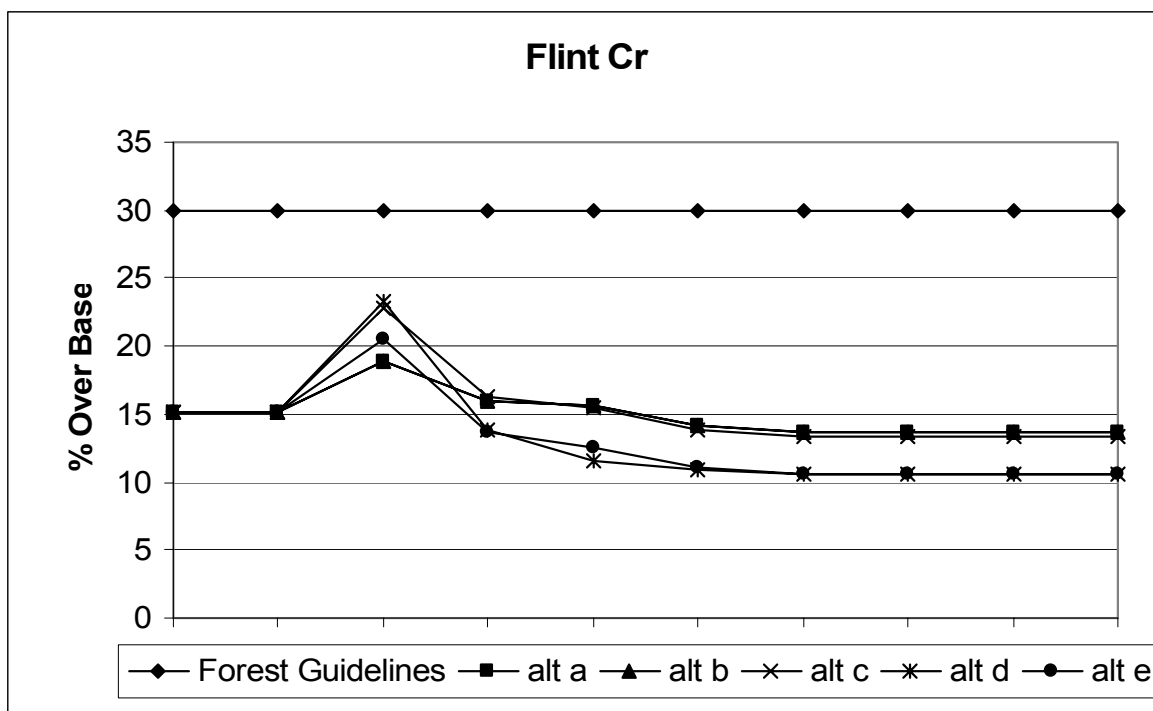
SEDIMENT YIELD GRAPHS

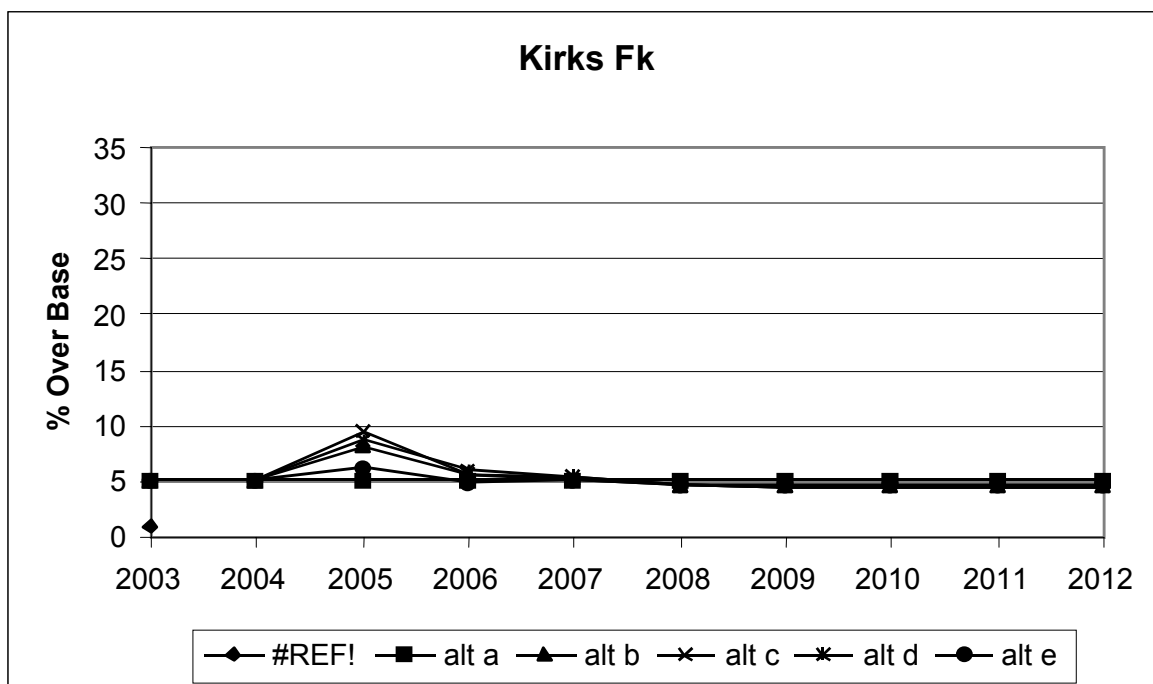
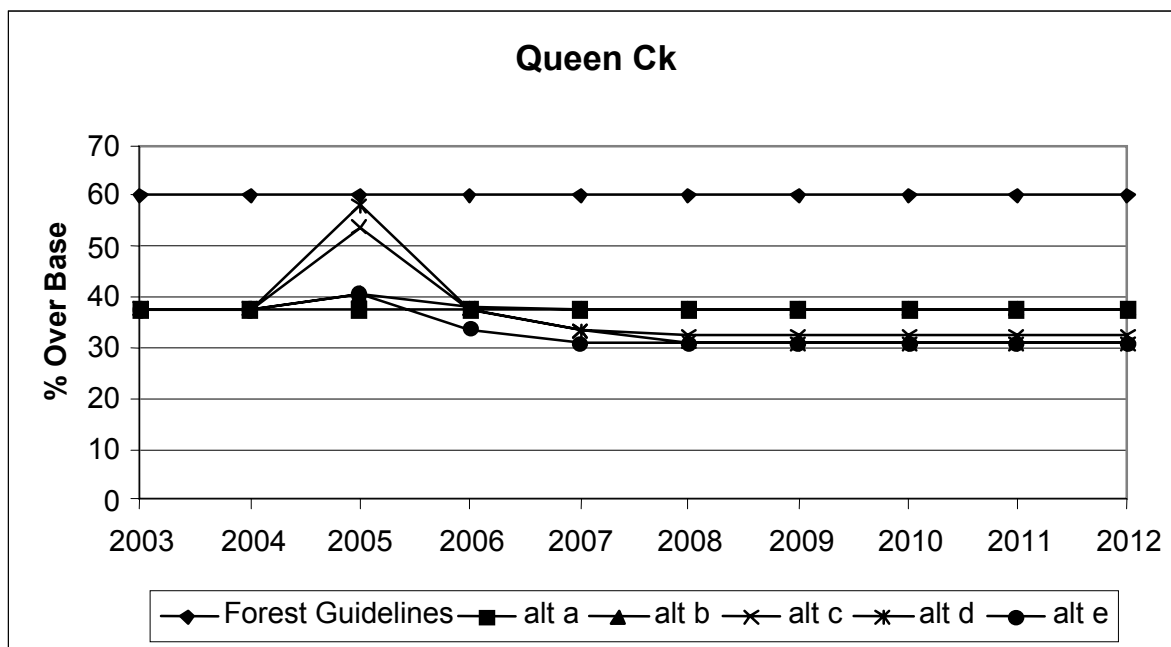
The following graphs show percent over base sediment yield by alternative for each analysis point in the American and Crooked River watersheds. These are the same data shown in tables in the Final Environmental Impact Statement, Section 3.2. – Watershed, except for the entire 10-year modeling period.

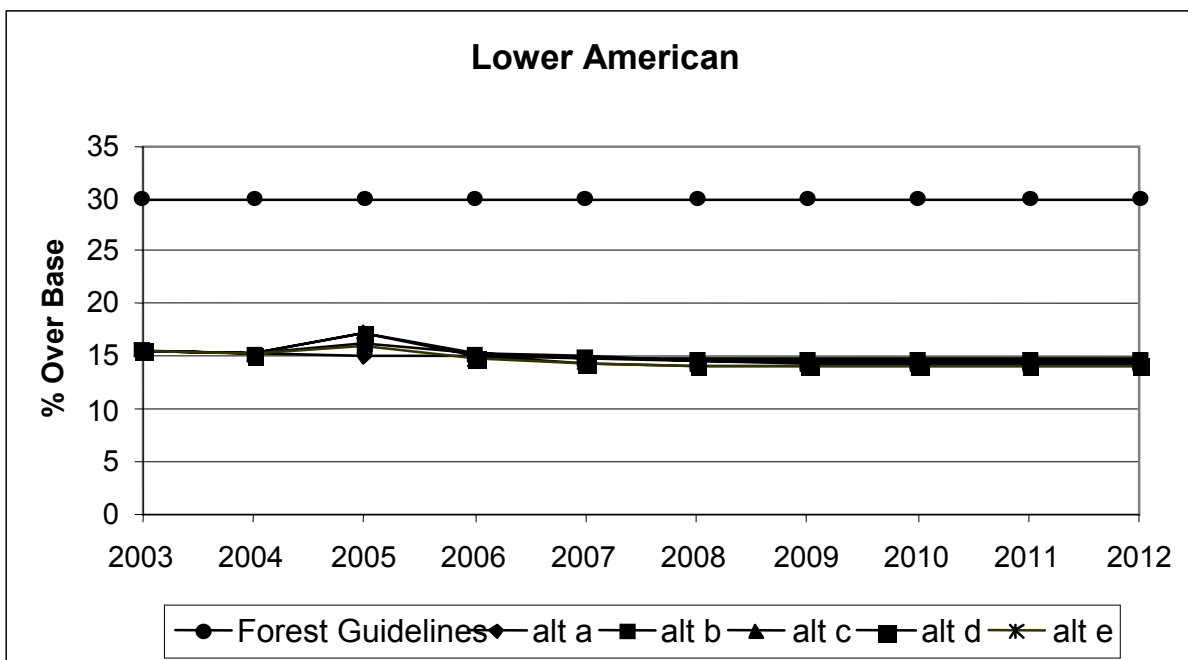
AMERICAN RIVER

- Figures E.4a-h: Sediment Yield – American River



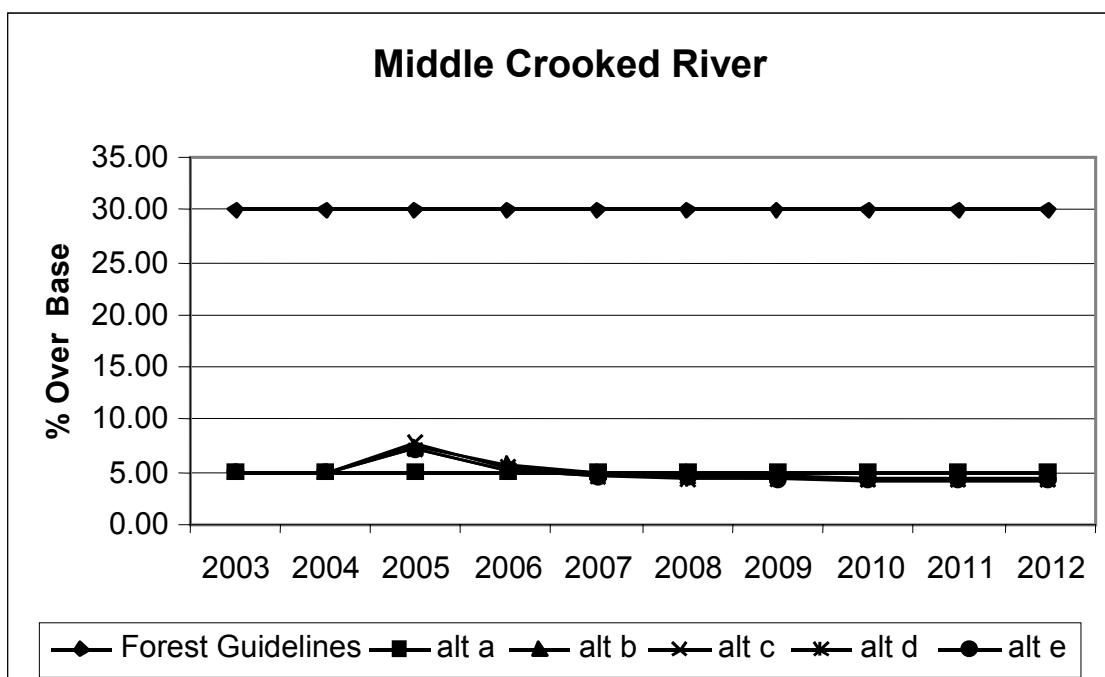


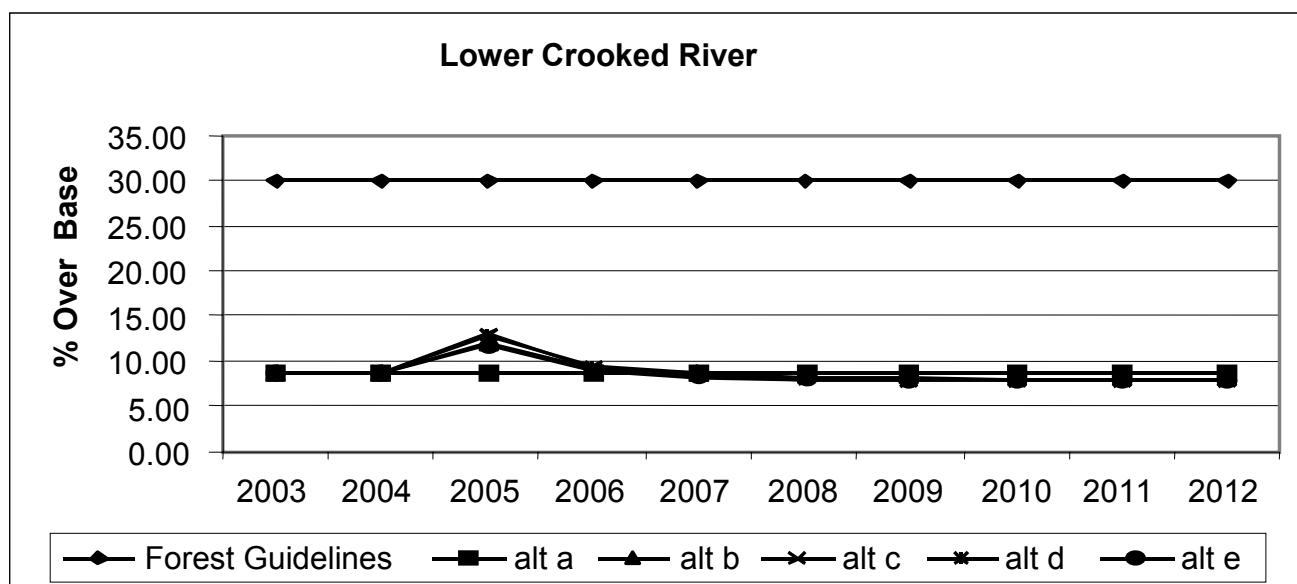
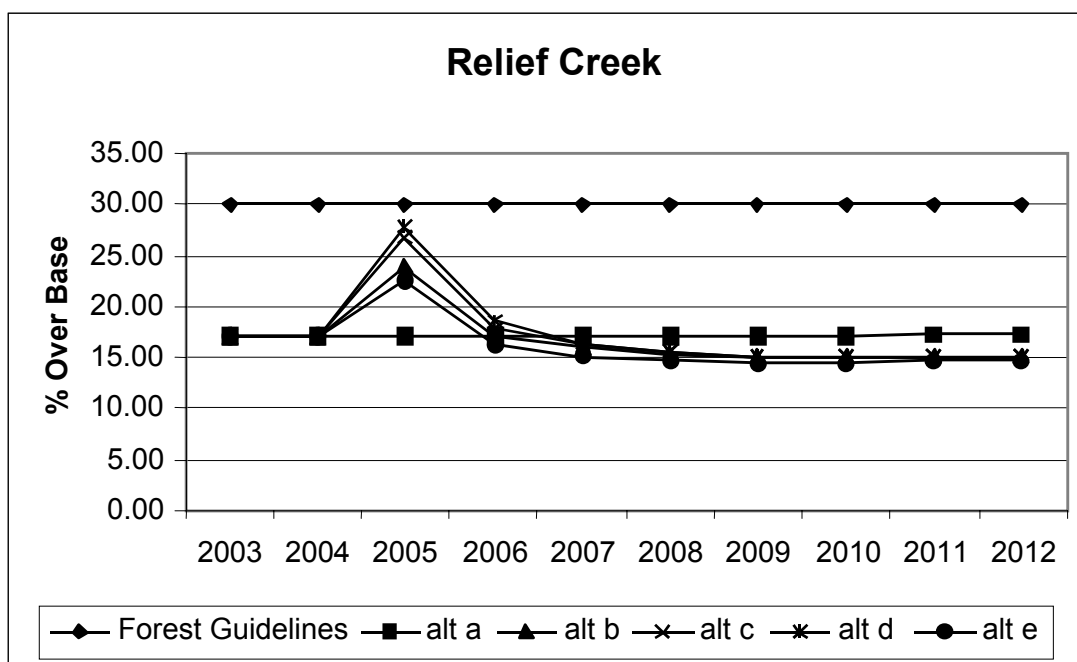




CROOKED RIVER

- Figures E.5a-c: Sediment Yield – Crooked River

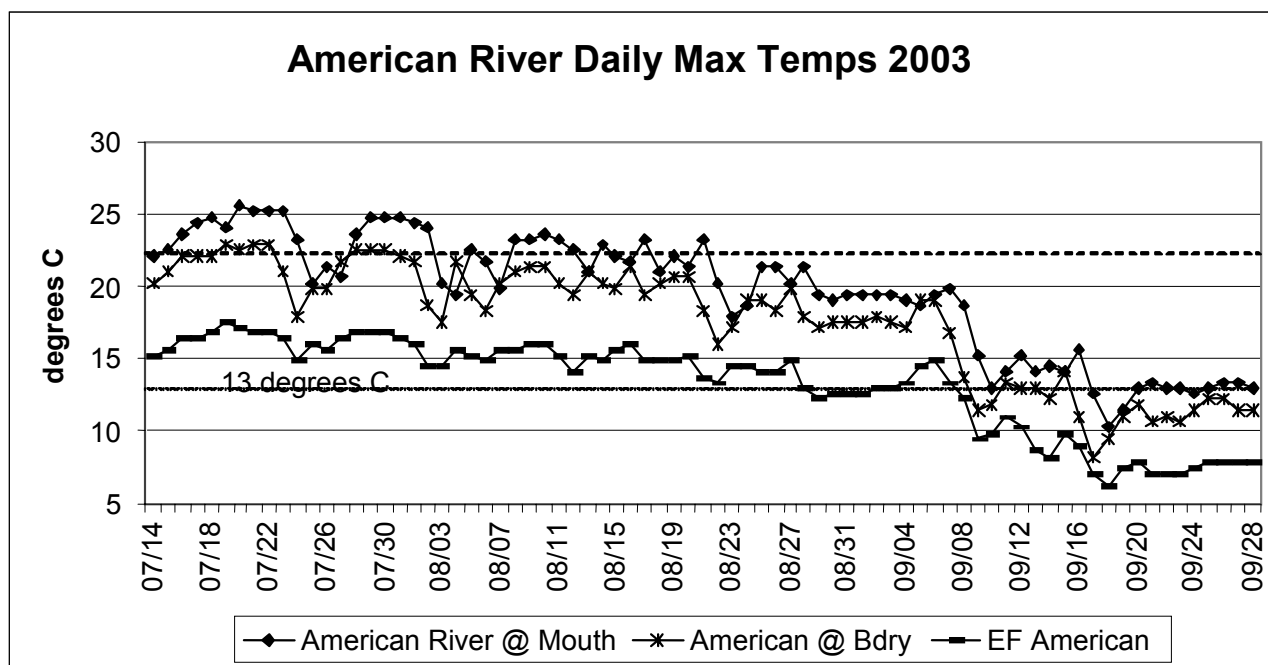
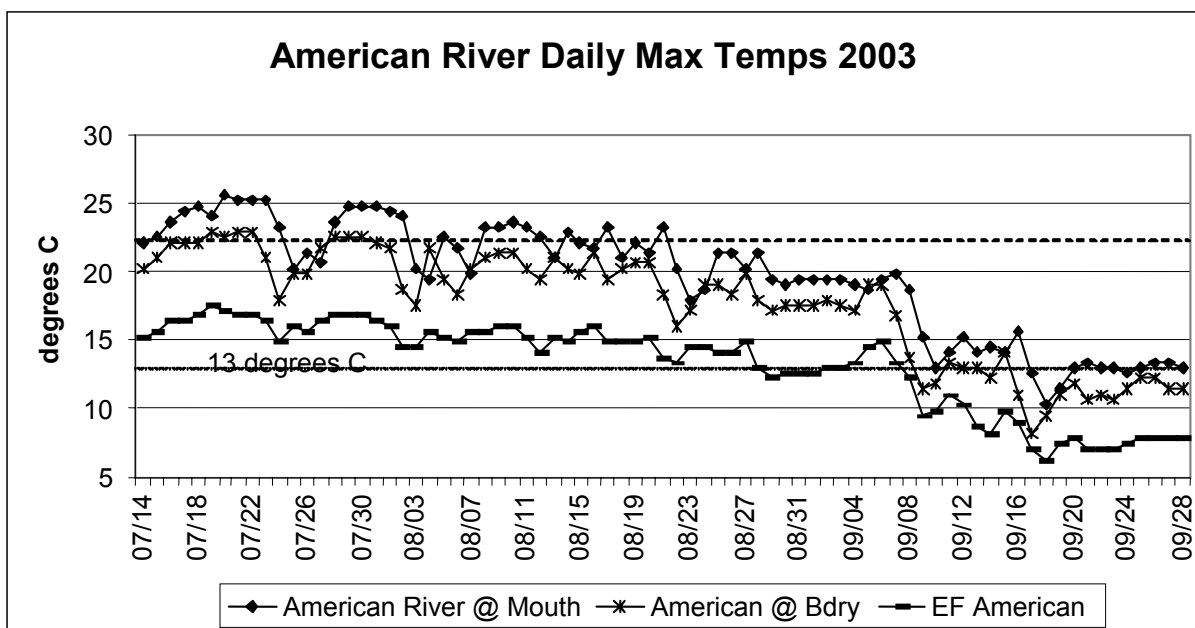


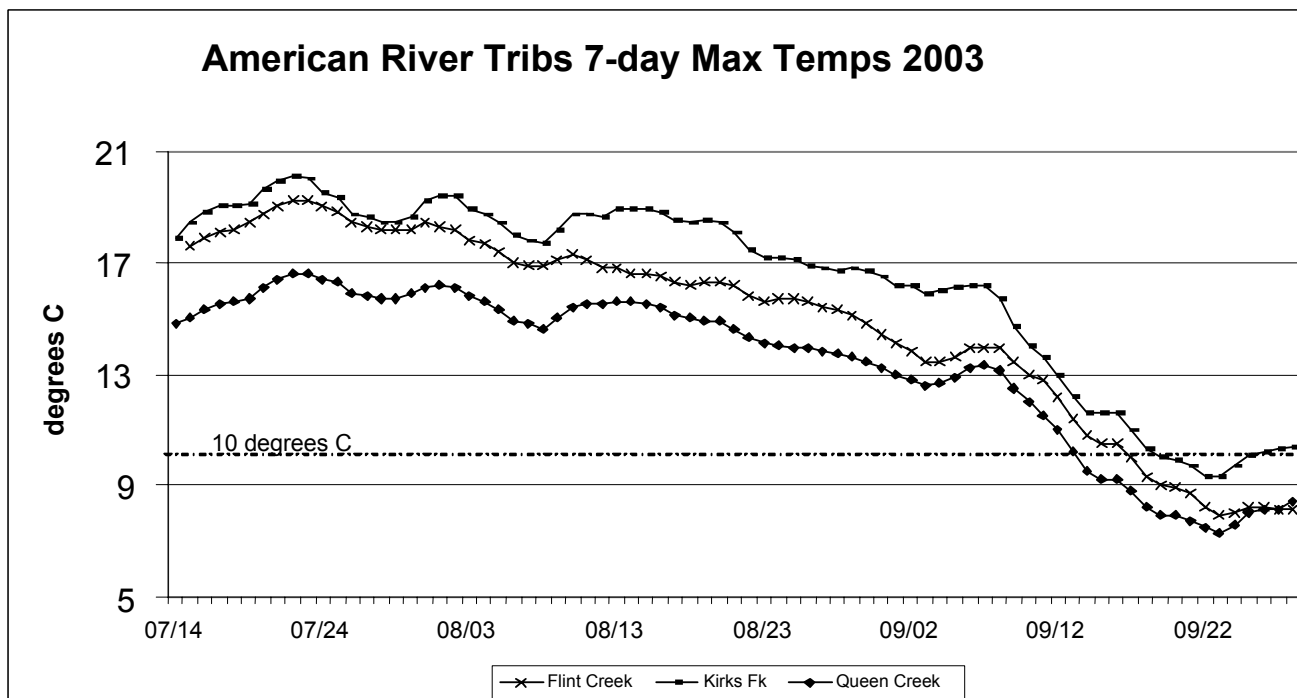
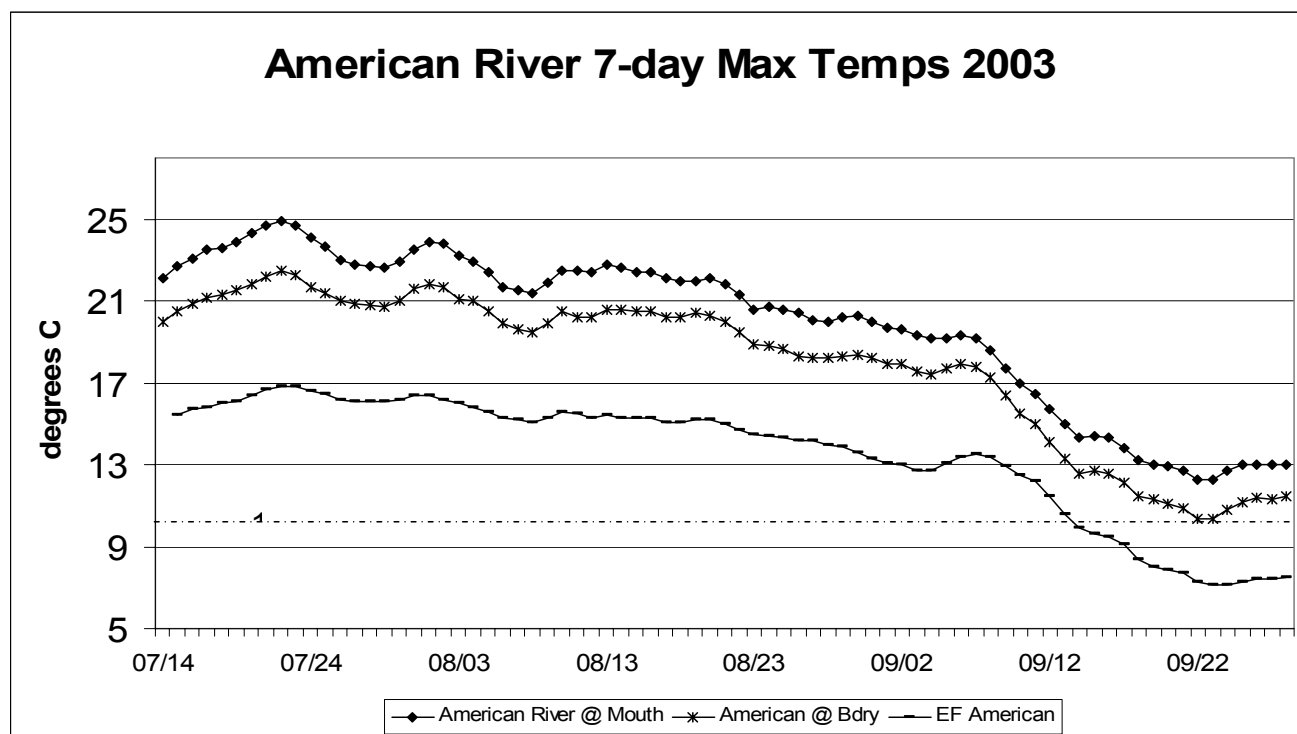


WATER TEMPERATURE

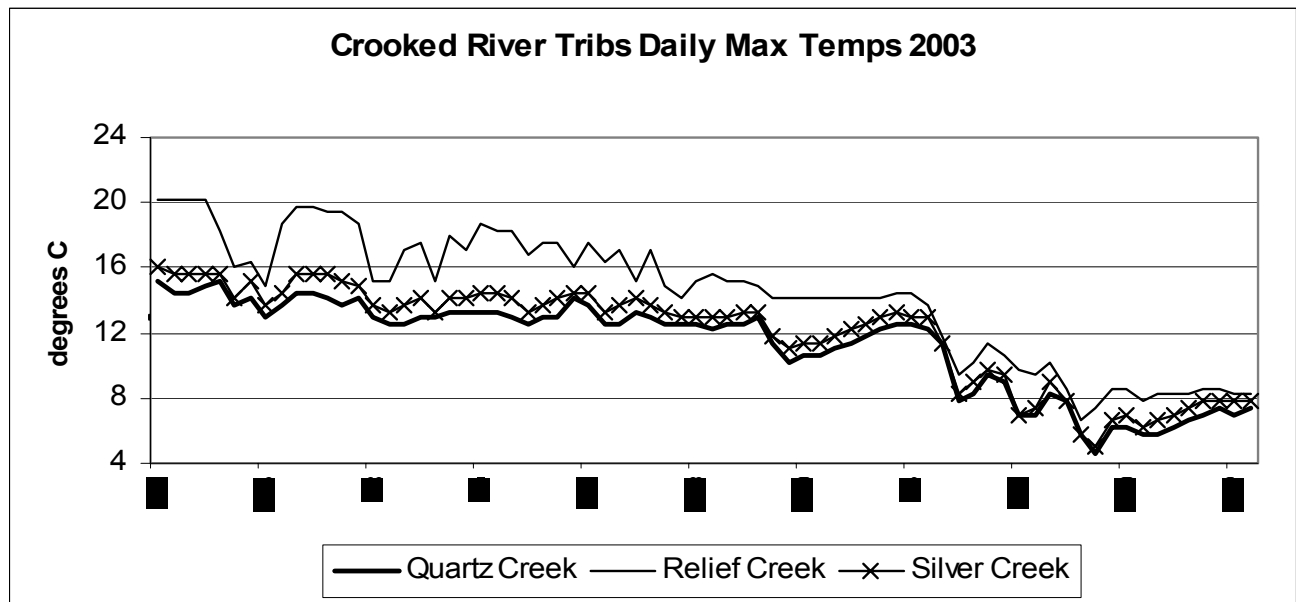
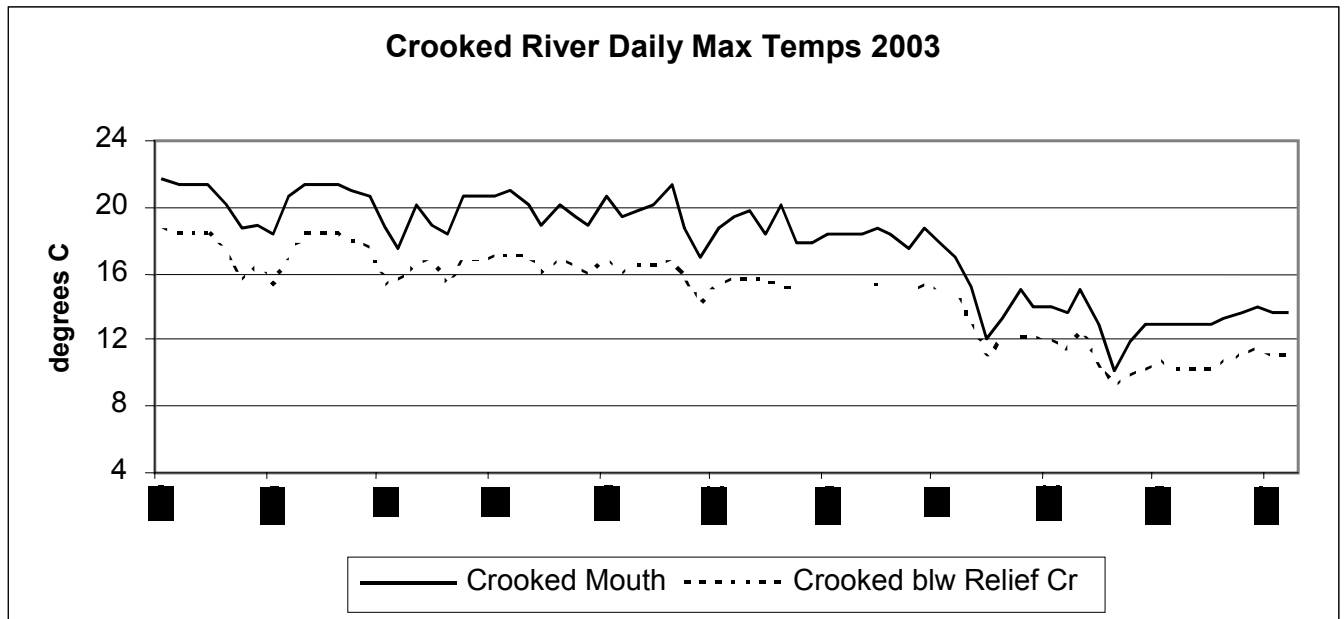
Water temperature data were collected in the American/Crooked project watersheds during the summer of 2003. These data are shown in Figures B-7 and B-8. Data have been collected on the mainstem South Fork Clearwater River at the Mt. Idaho Bridge since 1993. These are summarized in Table B-5 to provide a perspective on the 2003 summer. It is apparent that 2003 was the warmest summer in the past 10 years in terms of water temperature in the South Fork Clearwater River subbasin.

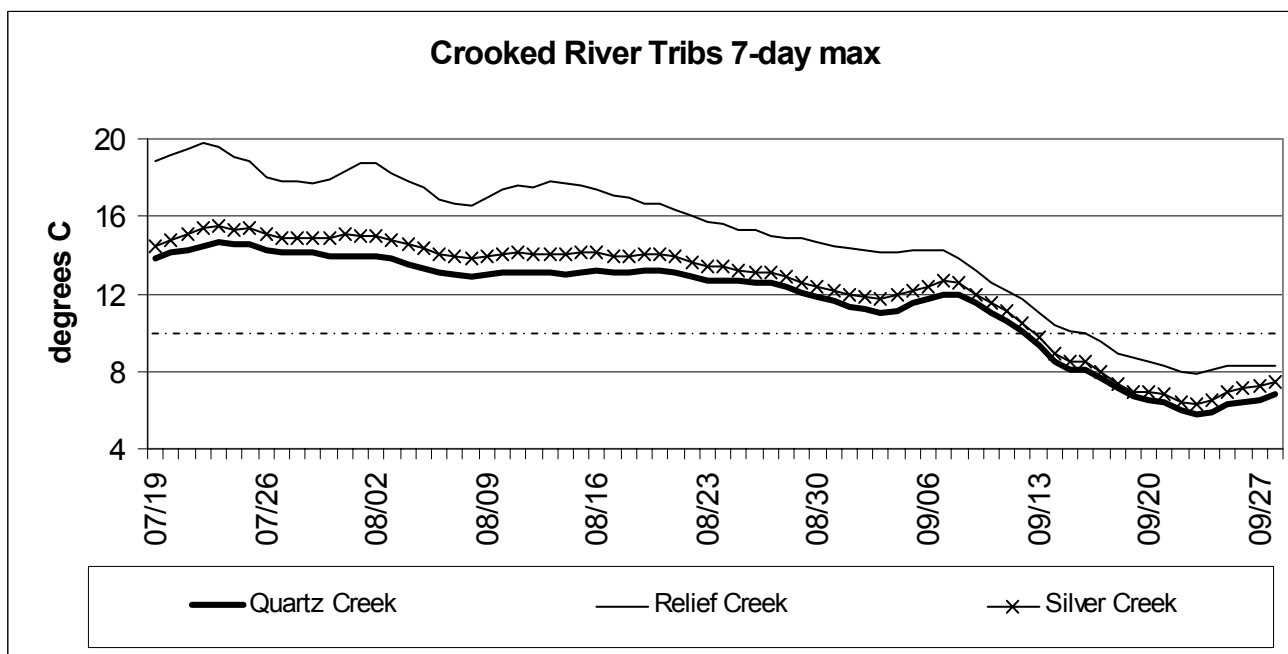
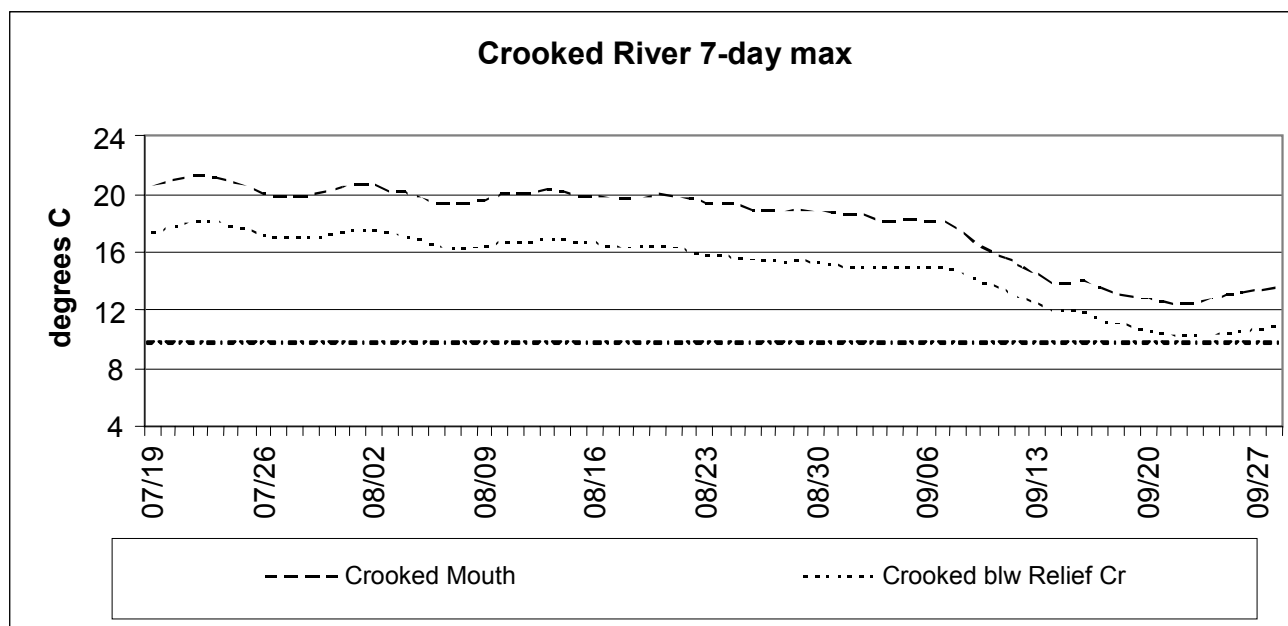
• **Figure E.6a-d: American River 2003 Water Temperature**





- Figure E.7a-d: Crooked River 2003 Water Temperature





WATER QUALITY DATA

Water quality data were collected by the Nez Perce National Forest at several locations in the project area during the period of 1974 – 1981. These are useful for general characterization of water quality conditions. The lowest numbers of samples were taken for pH and the larger numbers of samples were taken for conductivity and alkalinity. Some key water quality parameters are summarized in the tables below:

TABLE E.5: WATER QUALITY DATA – AMERICAN RIVER

Site Name	STORET Number	Number of Samples	pH		Conductivity (µmhos)		Alkalinity (mg/l)	
			Mean	Range	Mean	Range	Mean	Range
Upper American	NEXY04	15-49	6.7	6.3-7.4	27	20-45	15	8-26
Flint Creek	NETW20	4-29	6.9	6.4-7.4	20	16-29	11	7-18
Lower American	NEXT05	5-37	6.8	6.8-6.8	22	18-33	12	6-21

TABLE E.6: WATER QUALITY DATA – CROOKED RIVER

Site Name	STORET Number	Number of Samples	pH		Conductivity (µmhos)		Alkalinity (mg/l)	
			Mean	Range	Mean	Range	Mean	Range
Crooked River	NETW0	12	NA	NA	21	12-31	NA	NA
Relief Creek	NETW10	24-50	7.1	6.2-8.0	22	10-34	14	10-21

Sampling in Crooked River was limited in the studies summarized above. A subsequent water quality study was conducted in 1986 and 1987. In four samples taken under this study, pH ranged from 7.3 to 7.5, conductivity ranged from 35 to 47 µmhos, and alkalinity ranged from 18 to 20 mg/l (Mann and Von Lindern, 1988).

AQUATIC TREND ANALYSIS

INTRODUCTION TO TREND ANALYSIS

To assess the expected trend in aquatic habitat condition, from the variety of influences both quantitative and qualitative, the activities and their expected contribution to aquatic condition are summarized in a table below. The table is a summary of the expected influence of the alternatives on the aquatic conditions in the American and Crooked River watersheds respectively. It does not represent an assessment of cumulative effects, or expected trend within specific subwatersheds. Various activities are considered with respect to the variety of aquatic processes that they potentially affect.

The contribution to the overall aquatic condition is estimated in terms of positive influence (denoted by “+”) where the activity is expected to contribute to an improvement in condition, and a negative influence (denoted by “-”) where the activity is expected to contribute to degradation in aquatic condition. The amount of influence a specific activity is expected to have on the overall aquatic condition (either positive or negative) is represented by a ranking of high (H), moderate (M), or low (L). Activities rated “High” are those that are expected to have a significant effect at the watershed scale (considering both scope and magnitude). Those rated as “Moderate” are those activities that are expected to have a significant local effect (i.e. at the subwatershed scale), but not result in a significant effect at the watershed scale. Those activities rated “Low” are expected to have only a negligible effect both at the subwatershed and watershed scale.

All of the processes potentially affected by an activity are listed in the table. No ranking represents ‘no expected’ influence on conditions from this project. The expected contribution of a specific activity on aquatic condition is considered both in terms of short-term and long-term. Short-term influence is

judged to be the immediate results of implementing the activity, generally expected to be around a 5-year timeframe. Long-term influence is judged to be the influence the activity will have on aquatic condition as a result of changes in processes and resource conditions that will over time result in changes in aquatic habitat condition. The timeframe for this influence is greater than 5 years.

TREND ANALYSIS – AMERICAN RIVER

TABLE E.7: AQUATIC TREND ANALYSIS – AMERICAN RIVER

Action	Process Affected	Characteristic Indicator	Alt A Short Term	Alt A Long Term	Alt B Short Term	Alt B Long Term	Alt C Short Term	Alt C Long Term	Alt D Short Term Required Only	Alt D Long Term Required Only	Alt D Short Term Required + Additional	Alt D Long Term Required + Additional	Alt E Short Term	Alt E Long Term
Vegetation Treatments	Surface Erosion	Pulse & Chronic Sediment		-L	-L		-L		-L		-L			
	Mass Failure Risk	Pulse sediment												
	Infiltration, runoff, peaks	Hydrologic process		-L	-L		-L		-L		-L		-L	
	Solar heating	Riparian shade												
	LWD Recruitment	Potential LWD												
Temporary Road Construction	Surface erosion	Pulse & Chronic Sediment			-M		-M		-M		-M		-L	
	Mass failure risk	Pulse sediment												
	Infiltration, runoff, peaks	Hydrologic process			-L		-L		-L		-L			
	Fish passage	Habitat availability												
	Riparian shade	Riparian condition												
	LWD Recruitment	Potential LWD												
Road Recon and Improvement	Surface erosion	Pulse & Chronic Sediment			-M		-M		-M		-M		-L	
	Mass failure risk	Pulse Sediment												
	Infiltration, runoff, peaks	Hydrologic process												
	Fish passage	Habitat availability												
Road Decommissioning	Surface erosion	Pulse & Chronic Sediment			-L	+L	-L	+L	-L	+L	-M	+M	-M	+M
	Mass failure risk	Pulse sediment												
	Infiltration, runoff, peaks	Hydrologic process			+L	+L	+L	+L	+L	+L	+M	+M	+M	+M
	Fish Passage	Habitat availability												
	Riparian Shade	Riparian Condition												
	LWD Recruitment	Potential LWD												

Action	Process Affected	Characteristic Indicator	Alt A Short Term	Alt A Long Term	Alt B Short Term	Alt B Long Term	Alt C Short Term	Alt C Long Term	Alt D Short Term Required Only	Alt D Long Term Required Only	Alt D Short Term Required + Additional	Alt D Long Term Required + Additional	Alt E Short Term	Alt E Long Term
Stream Crossing Improvement	Surface erosion	Pulse & Chronic Sediment			-L		-L		-L		-L		-L	
	Mass failure risk	Pulse sediment												
	Infiltration, runoff, peaks	Hydrologic process			+L	+L	+L	+L	+L	+L	+M	+M	+M	+M
	Fish passage	Habitat availability			+L	+L	+L	+L	+L	+L	+M	+M	+M	+M
In-channel & Riparian Restoration	Construction sediment	Pulse & Chronic Sediment												
	Habitat Quality	Channel Dimensions												
	Riparian shade	Riparian Condition												
	LWD Recruitment	Acting LWD												
Soil Restoration	Surface erosion	Pulse & chronic Sediment												
	Mass failure risk	Pulse sediment												
	Infiltration, runoff, peaks	Hydrologic process			+L	+L	+L	+L	+L	+L	+M	+M	+M	+M
	Riparian Shade	Riparian Condition												
Mine Site Reclamation	Surface Erosion	Pulse & Chronic Sediment												
	Infiltration, runoff, etc.	Hydrologic process												
	Riparian Interaction, shade	Riparian Conditions												
Rec & Trail Improvements	Surface Erosion	Pulse & Chronic Sediment			+L	+L	+L	+L	+L	+L	+L	+L	+L	+L
	Infiltration, Runoff, etc.	Hydrologic Processes												
	Riparian Interaction, Shade	Riparian Condition												

The expected short-term consequences of the American and Crooked River project on aquatic condition in American River are fairly balanced between positive and negative influences. The factors contributing to a short-term reduction in aquatic condition are principally related to the sediment pulse generated from the implementation of the action (timber harvest, temporary road construction, road decommissioning, road reconstruction and improvement, and culvert replacement). The temporary

road construction is judged to be the largest contributor to this influence, followed by the harvest activities, road decommissioning, and road reconstruction and improvement. The factors contributing to an immediate short-term improvement in aquatic condition are related to; the reduction in chronic sediment and improvement in the hydrologic process from road decommissioning, road reconstruction and improvement, and soil restoration; and the immediate improvements in habitat accessibility from culvert upgrades and road decommissioning are judged to be the largest contributors to this improvement.

The expected long-term consequences of the American and Crooked River project on aquatic condition in the American River watershed are all positive. The road decommissioning and improved habitat accessibility from the culvert upgrades are judged to be the largest contributors to long-term improved aquatic conditions. The reduction in chronic sediment and improved hydrologic process from the road decommissioning, road improvement, and soil restoration are the other contributors to this expected improvement. The amount of the improvement associated with this later group of activities is rated low due to the amount of this work being completed with this project with respect to the remaining amount of degraded mainstem habitat, roads and compacted soils in the American River watershed. These will continue to contribute negatively to these aquatic processes. Planned Bureau of Land Management work in this drainage will further improve in channel and riparian conditions along the mainstem as well as tributary streams.

The above ratings by activity can be summarized by the effect pathways by assigning a value to the Low, Moderate, and High ranking (L=1, M=2, H=3). The table below summarizes the alternatives by the effect pathway and for the alternative in general (total).

TABLE E 8: AQUATIC TREND SUMMARY – AMERICAN RIVER

Action	Process Affected	Characteristic Indicator	Alt A Short Term	Alt A Long Term	Alt B Short Term	Alt B Long Term	Alt C Short Term	Alt C Long Term	Alt D Short Term Required Only	Alt D Long Term Required Only	Alt d Short Term Required + Additional	Alt D Long Term Required + Additional	Alt E Short Term	Alt E Long Term
Summary	Surface Erosion	Pulse & Chronic Sediment	0	-1	-6	2	-6	2	-6	2	-7	3	-4	3
	Mass Failure Risk	Pulse sediment	0	0	0	0	0	0	0	0	0	0	0	0
	Infiltration, runoff, peaks	Hydrologic process	0	-1	1	3	1	3	1	3	4	6	5	6
	Riparian Shade	Riparian shade	0	0	0	0	0	0	0	0	0	0	0	0
	LWD Recruitment	Acting LWD	0	0	0	0	0	0	0	0	0	0	0	0
	Fish passage	Habitat availability	0	0	1	1	1	1	1	1	2	2	2	2
	Habitat Quality	Channel Dimensions	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL			0	-2	-4	6	-4	6	-4	6	-1	11	3	11

The No Action alternative in American River suggests no change in the short term, but a slight negative trend in the long term related to fire risk associated with untreated stands. Alternatives B, C, and D (the latter with only required improvement projects) suggest a short term negative effect, followed by long term improving trend. Alternative D, including the required and additional

improvement projects, suggests a slight short-term negative effect, followed by a greater long term improving trend than the previous action alternatives. Alternative E suggests a slight short term improvement, followed by a similar long term improving trend as Alternative D, when both required and additional improvement projects are considered. The larger amount of improving trend in Alternatives D and E occur in large part as a result of the greater amount of road decommissioning, when both required and additional projects are considered.

TREND ANALYSIS – CROOKED RIVER

TABLE E.9: AQUATIC TREND ANALYSIS – CROOKED RIVER

Action	Process Affected	Characteristic Indicator	Alt A Short Term	Alt A Long Term	Alt B Short Term	Alt B Long Term	Alt C Short Term	Alt C Long Term	Alt D Short Term Required Only	Alt D Long Term Required Only	Alt d Short Term Required + Additional	Alt D Long Term Required + Additional	Alt E Short Term	Alt E Long Term
Vegetation Treatments	Surface Erosion	Pulse & Chronic Sediment		-L	-M		-M		-M		-M		-M	
	Mass Failure Risk	Pulse sediment												
	Infiltration, runoff, peaks	Hydrologic process		-L	-L		-L		-L		-L		-L	
	Solar heating	Riparian shade												
	LWD Recruitment	Potential LWD												
Temporary Road Construction	Surface erosion	Pulse & Chronic Sediment			-M		-M		-M		-M		-M	
	Mass failure risk	Pulse sediment												
	Infiltration, runoff, peaks	Hydrologic process			-L		-L		-L		-M		-L	
	Fish passage	Habitat availability												
	Riparian shade	Riparian condition												
	LWD Recruitment	Potential LWD												
Road Recon and Improvement	Surface erosion	Pulse & Chronic Sediment			-M		-M		-M		-M		-M	
	Mass failure risk	Pulse Sediment												
	Infiltration, runoff, peaks	Hydrologic process												
	Fish passage	Habitat availability												

Action	Process Affected	Characteristic Indicator	Alt A Short Term	Alt A Long Term	Alt B Short Term	Alt B Long Term	Alt C Short Term	Alt C Long Term	Alt D Short Term Required Only	Alt D Long Term Required Only	Alt d Short Term Required + Additional	Alt D Long Term Required + Additional	Alt E Short Term	Alt E Long Term
Road Decommissioning	Surface erosion	Pulse & Chronic Sediment		-L	-L	+L	-L	+L	-L	+L	-M	+M	-M	+M
	Mass failure risk	Pulse sediment										+L		+L
	Infiltration, runoff, peaks	Hydrologic process		-L	+L	+L	+L	+L	+L	+L	+M	+M	+M	+M
	Fish Passage	Habitat availability												
	Riparian Shade	Riparian Condition												
	LWD Recruitment	Potential LWD												
Stream Crossing Improvement	Surface erosion	Pulse & Chronic Sediment			-L		-L		-L		-M		-M	
	Mass failure risk	Pulse sediment												
	Infiltration, runoff, peaks	Hydrologic process			+L	+L	+L	+L	+L	+L	+M	+M	+M	+M
	Fish passage	Habitat availability			+L	+L	+L	+L	+L	+L	+M	+M	+M	+M
In-channel & Riparian Restoration	Construction sediment	Pulse & Chronic Sediment			-L		-L		-L		-M		-M	
	Habitat Quality	Channel Dimensions	-L	-L	+M	+M	+M	+M	+M	+M	+H	+H	+H	+H
	Riparian shade	Riparian Condition				+L		+L		+L		+M		+M
	LWD Recruitment	Acting LWD			+M	+M	+M	+M	+M	+M	+H	+H	+H	+H
Soil Restoration	Surface erosion	Pulse & chronic Sediment												
	Mass failure risk	Pulse sediment												
	Infiltration, runoff, peaks	Hydrologic process			+L	+L	+L	+L	+L	+L	+M	+M	+M	+M
	Riparian Shade	Riparian Condition												

Action	Process Affected	Characteristic Indicator	Alt A Short Term	Alt A Long Term	Alt B Short Term	Alt B Long Term	Alt C Short Term	Alt C Long Term	Alt D Short Term Required Only	Alt D Long Term Required Only	Alt d Short Term Required + Additional	Alt D Long Term Required + Additional	Alt E Short Term	Alt E Long Term
Mine Site Reclamation	Surface Erosion	Pulse & Chronic Sediment			-L		-L		-L		-L		-L	
	Infiltration, runoff, etc.	Hydrologic process			+L	+L	+L	+L	+L	+L	+L	+L	+L	+L
	Riparian Interaction, shade	Riparian Conditions				+L		+L		+L		+L		+L
Rec & Trail Improvements	Surface Erosion	Pulse & Chronic Sediment			+L	+L	+L	+L	+L	+L	+L	+L	+L	+L
	Infiltration, Runoff, etc.	Hydrologic Processes			+L	+L	+L	+L	+L	+L	+L	+L	+L	+L
	Riparian Interaction, Shade	Riparian Condition												

The expected short-term consequences of the American and Crooked River project on aquatic condition in the Crooked River watershed is fairly balanced between positive and negative influences. The factors contributing to a short-term reduction in aquatic condition are principally related to the sediment pulse generated from the implementation of the action (timber harvest, temp road construction, road decommissioning, road reconstruction and improvement, soil restoration, and in-channel aquatic improvements). The temporary road construction is judged to be the largest contributor to this influence, followed by the harvest activities, road decommissioning, and road reconstruction and improvement. The factors contributing to an immediate short-term improvement in aquatic condition are related to: the reduction in chronic sediment and improvement in the hydrologic process from road decommissioning, road reconstruction and improvement, and soil restoration; and the immediate improvements in habitat accessibility and riparian and instream conditions from the direct improvement projects (culvert upgrades, riparian planting, and in channel improvements). The in channel and riparian restoration are judged to be the largest contributor to this improvement, followed by the road decommissioning, culvert upgrades, soil restoration, recreation site and mine site improvements.

The expected long-term consequences of the American and Crooked River project on aquatic condition in the Crooked River watershed are all positive. The in channel habitat and riparian restoration work is judged to be the largest contributor to long-term improved aquatic conditions. The reduction in chronic sediment and improved hydrologic process from the road decommissioning, road improvement, culvert upgrades, soil restoration, and mine and recreation site improvements are the other contributors to this expected improvement. The amount of the in channel and riparian work will contribute correspondingly to the degree of long-term improvement in Crooked River.

The above ratings by activity can be summarized by the effect pathways by assigning a value to the Low, Moderate, and High ranking (L=1, M=2, H=3). The table below summarizes the alternatives by the effect pathway and for the alternative in general (total).

TABLE E.10: AQUATIC TREND SUMMARY – CROOKED RIVER

Action	Process Affected	Characteristic Indicator	Alt A Short Term	Alt A Long Term	Alt B Short Term	Alt B Long Term	Alt C Short Term	Alt C Long Term	Alt D Short Term Required Only	Alt D Long Term Required Only	Alt d Short Term Required + Additional	Alt D Long Term Required + Additional	Alt E Short Term	Alt E Long Term
Summary	Surface Erosion	Pulse & Chronic Sediment	0	-1	-9	2	-9	2	-9	2	-12	3	-12	3
	Mass Failure Risk	Pulse sediment	0	0	0	0	0	0	0	0	0	1	0	1
	Infiltration, runoff, peaks	Hydrologic process	0	-1	3	5	3	5	3	5	6	8	6	8
	Riparian Shade	Riparian shade	0	0	0	2	0	2	0	2	0	3	0	3
	LWD Recruitment	Acting LWD	0	0	2	2	2	2	2	2	3	3	3	3
	Fish passage	Habitat availability	0	0	1	1	1	1	1	1	2	2	2	2
	Habitat Quality	Channel Dimensions	-1	-1	2	2	2	2	2	2	3	3	3	3
TOTAL			-1	-3	-1	14	-1	14	-1	14	2	23	2	23

The No Action alternative in Crooked River suggests a slight negative effect in the short term related to ongoing maintenance needs at instream structures and a slight negative trend in the long term related to fire risk associated with untreated stands. Alternatives B, C, and D (the latter with only required improvement projects considered) suggest a short term negative effect, followed by long term improving trend. Alternatives D (including the required and additional improvement projects) and E suggest a slight short-term positive effect, followed by a greater long term improving trend than the previous action alternatives. The larger amount of improving trend in Alternatives D and E occur in large part as a result of the greater amount of road decommissioning and instream improvements, when both required and additional projects are considered.

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